

DESCRIPTIONS OF FOUR NEW SPECIES OF CYNIPID GALL WASPS OF
THE GENUS *NEUROTERUS* HARTIG (HYMENOPTERA: CYNIPIDAE) WITH
REDESCRIPTIONS OF SOME KNOWN SPECIES FROM THE EASTERN
UNITED STATES

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Abstract.—Four new species of cynipid gall wasps of the genus *Neuroterus* Hartig from the eastern United States are described: *N. archboldi* Melika and Abrahamson, *N. chapmanii* Melika and Abrahamson, *N. christi* Melika and Abrahamson, and *N. weldi* Melika and Abrahamson. Four common eastern United States species of *Neuroterus* are redescribed and four species are newly synonymized: *N. quercusbatatus* (Fitch) (*Cynips noxiosus* Bassett, **new synonymy**); *N. quercusirregularis* (Osten Sacken) (*Cynips quercusmajalis* Bassett, **new synonymy**); *N. quercusminutissimus* (Ashmead); and *N. quercusverrucarum* (Osten Sacken) (*Cynips floccosus* Bassett and *Neuroterus exiguissimus* Bassett, **new synonymies**).

Key Words: Cynipidae, gall wasps, *Neuroterus*, taxonomy, morphology, distribution, biology

Neuroterus Hartig, 1840, is a holarctic genus with numerous representatives in the Old World (Eurasia) and North America. Burks (1979) listed 52 species for America north of Mexico, 33 of which are restricted to the eastern United States. This genus is easily distinguished from other genera of oak gall-inducing cynipids by the absence of a scutoscutellar suture; usually smooth and thin body with a delicate coriaceous or alutaceous sculpture on the thorax; radial cell of fore wing long and narrow; and usual absence of notauli. All known species of this genus cause galls only on oaks of the subgenus *Lepidobalanus*, except *N. chrysolepis* Lyon which is associated with *Quercus chrysolepis* Liebm. of the subgenus *Protobalanus* (Lyon 1984). The structure of *Neuroterus* galls is usually more primitive than those of other genera, and they lack highly specialized tissues and lay-

ers. Furthermore, the walls of the larval cell usually are incorporated into the outer tissues of the gall and do not separate from the gall's wall when the insect matures.

Numerous species of *Neuroterus* were described from the eastern United States before the end of the previous century, and very often the only differences among the described species were the host oaks from which the galls were collected. Furthermore, the descriptions of the species are incomplete and insufficient. Thus, eight common species of *Neuroterus* known from the eastern United States are very difficult to identify, either on the basis of the galls or adults. These are *N. quercusirregularis* (Osten Sacken) and *N. quercusmajalis* (Bassett); *N. quercusbatatus* (Fitch) and *N. noxiosus* (Bassett); and *N. exiguissimus* Bassett, *N. floccosus* (Bassett), *N. quercusminutissimus* (Ashmead), and *N. quercusverrucarum* (Os-

ten Sacken). The descriptions and diagnostic characters for separation of these species given by various authors (Ashmead 1885a, 1885b, 1887; Bassett 1864, 1881, 1900; Fitch 1859; Osten Sacken 1861, 1865) hardly allow discrimination of all species. Examination of types of these species indicates that some are synonyms. Kinsey (1923), in his revision of *Neuroterus*, treated *N. exiguissimus*, *N. floccosus*, and *N. minutissimus* as varieties of *N. quercusverrucarum*; *N. noxiosus* as a variety of *N. quercusbatatus*, and *N. quercusmajalis* as a variety of *N. quercusirregularis*. He was correct in splitting these species, except *N. quercusminutissimus* which, in our opinion, is a distinct species. However, Kinsey's synonymies did not follow the International Code of Zoological Nomenclature. Furthermore, his use of "variety" and "form" makes his classification confusing and difficult to use. Nevertheless, we give credit to Kinsey for recognizing the similarities among the above-listed species. Thus, redescriptions, diagnostic characters, taxonomic comments, and data on distribution and biology for these eight species are given.

We follow the current terminology for morphological structures (Eady and Quinlan 1963, Fergusson 1995, Gibson 1985, Menke 1993, Ritchie and Peters 1981, Ronquist and Nordlander 1989). The term "thorax" used here includes the propodeum and thus is equivalent to the "mesosoma" or "mesosoma+metasoma" of the American literature. Abbreviations for fore wing venation follow Ronquist and Nordlander (1989). Measurements and abbreviations used here include: F1–F12, first and subsequent flagellomeres; POL (post-ocellar distance), the distance between the inner margins of the posterior ocelli; and OOL (odellar-ocular distance), the distance from the outer edge of a posterior ocellus to the inner margin of the compound eye.

Depositories for specimens are the National Museum of Natural History, Smithsonian Institution, Washington, D.C. (USNM) and the American Museum of

Natural History, New York, New York (AMNH).

***Neuroterus archboldi* Melika and
Abrahamson, NEW SPECIES**
(Figs. 1-6)

Diagnosis.—No *Neuroterus* galls known from the United States have galls similar to *N. archboldi* (Figs. 5, 6).

Description.—Bisexual female: Dark brown to black, with frons, clypeus and mouthparts of some specimens yellow brown. Head from above about twice as wide as long, slightly broader than thorax, gena not broadened behind eye (Fig. 1); interocular space punctate, black, broader than high; vertex finely coriaceous; distance between antennal sockets shorter than distance between socket and inner margin of eye; no distinct carina between antennal sockets; frons punctate, broader than high, yellow brown or yellow, with few scattered pale setae; clypeus yellow, rounded, its apex distinctly emarginate; anterior tentorial pits deep; malar space short, with faint malar groove. Antenna 13-segmented, yellow, as long as head and thorax together, with pale dense setae, basal 4 segments lighter than rest; F1 slightly shorter than pedicel and scape together, twice as long as F2 (Fig. 2). Scutum rounded, only very slightly broader than long, smooth and shining, very finely coriaceous, without trace of notauli, anterior parallel, and parapsidal lines; posterior margin slightly emarginate on both sides of transverse groove at base of scutellum; groove deep, smooth. Scutellum slightly longer than broad, smooth, shining, finely coriaceous with very few scattered short, pale setae. Pronotum, mesepisternum, and sides of propodeum finely punctate, lighter than scutum and scutellum. Medial part of propodeum uniformly sculptured, without carinae. Fore wing 1.5 mm long, uniformly and densely hairy, longer than body, with cilia on margins, with light smoky spot on M at junction of Cu₁; veins thick, brown, Rs+M reaches M; areolet distinct, triangu-

larly rounded (Fig. 4). Legs, including coxae pale yellow, semitranslucent, pretarsus dark brown to black; claws without tooth. Gaster darkish brown, smooth, in dry shrunken specimens, nearly same height and length; tip of ovipositor slightly curved, ventral spine of hypopygium visible laterally, with short sparse pale setae. Length, 1.3-1.4 mm. Male: Color lighter than female, except for head. Eye slightly larger than in female, interocular space black, punctate, with duller sculpture than finely coriaceous vertex. Anterior tentorial pits indistinct (unusual for males of species that induce integral leaf galls; usually males with very deep tentorial pits). Antenna 14-segmented, F1 longer than pedicel and scape together, only very slightly curved and extended in posterior part (Fig. 3). Fore wing slightly darker than in female, larger, length 2.0 mm. Petiole very distinct, long. Length, 1.3 mm.

Types.—Holotype ♀; allotype ♂ from Archbold Biological Station, Lake Placid, Highlands Co., Florida, on *Q. chapmanii* Sarg., 28 March 1995, emerged 30 March 1995. Also 25 ♀ and 4 ♂ paratypes. Holotype, allotype, 4 ♀ paratype, 1 ♂ paratype, and galls in the USNM; 5 ♀ paratypes, 1 ♂ paratype and galls in AMNH; 15 ♀ paratype, 2 ♂ paratypes, and galls in G. Melika private collection.

Etymology.—Named in honor of Mr. Richard Archbold, founder of the Archbold Biological Station.

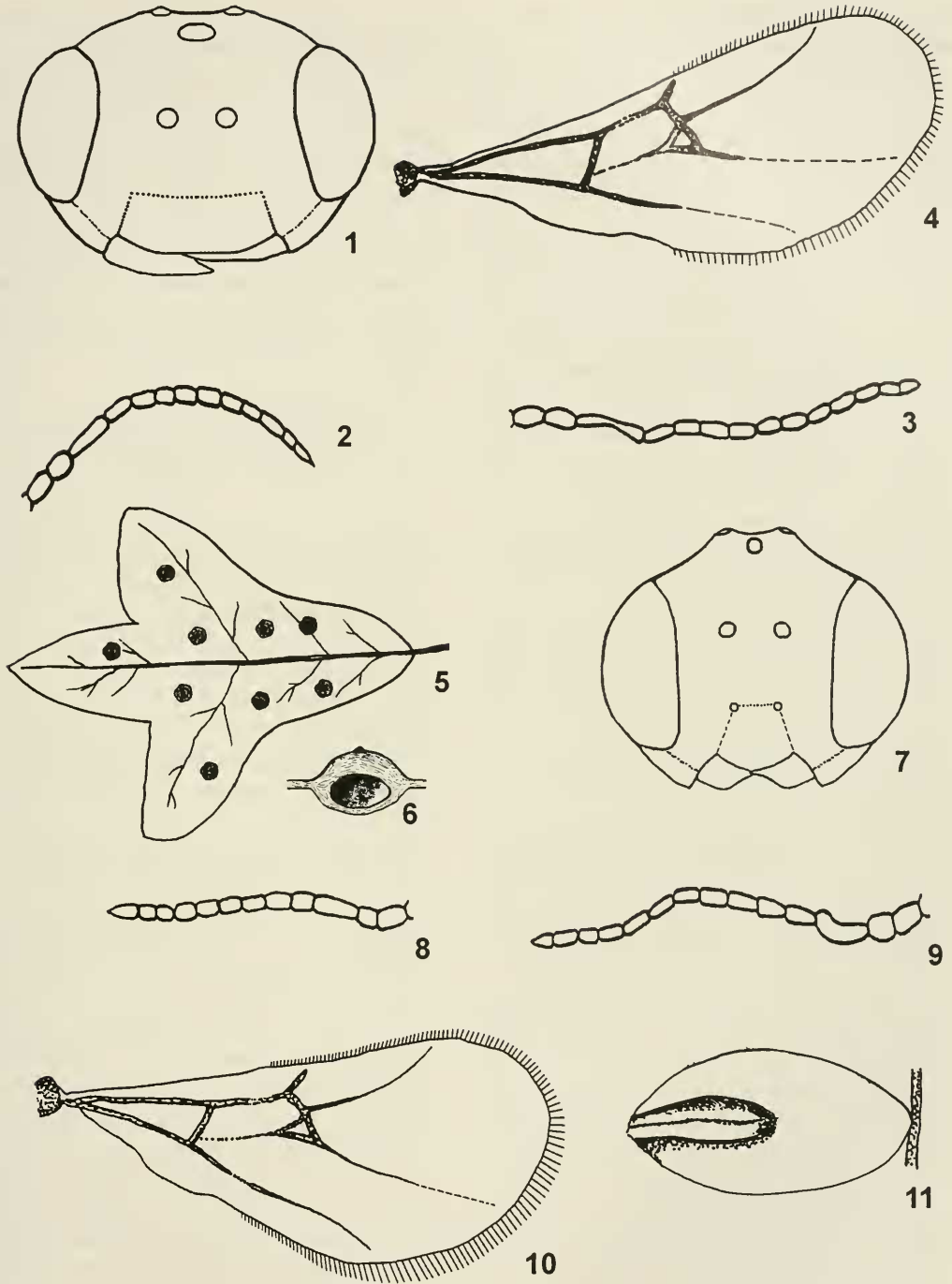
Distribution.—Florida (Archbold Biological Station, Lake Wales Ridge, Highlands Co.; Jonathan Dickinson State Park, Martin Co.).

Biology.—Only the bisexual generation is known, and the only known host for *N. archboldi* is *Quercus chapmanii*. This species induces blister-like parenchyma thickenings which are visible on both sides of the leaf but protrude more on the underside of the leaf. The gall is rounded, monothalamous, 1.5-2.0 mm in diameter, 1.0-1.5 mm high, green or whitish green, very slightly lighter than the leaf, and drier than the suc-

culent polythalamous *N. quercusirregularis* galls (Figs. 5, 6). The larval cell is situated on the underside of the leaf, not separated from the outer layers of the gall. There are 18 to 25 or more galls per leaf. After adults emerge, the galls shrink and wrinkle and dry out and drop. Consequently, rounded holes remain in the leaf. We observed these galls actively growing for the first time on 9 March 1995. Adults emerged the second and third week of March into April. They were very common leaf galls on *Q. chapmanii* at the Archbold Biological Station. Simultaneous with this species, *N. quercusirregularis* galls could develop on the same leaf, but they are easily distinguishable from those of the former on the basis of galls. Our efforts to rear the alternate generation in cages containing emerged wasps on Chapman oaks were unsuccessful.

Neuroterus chapmanii Melika and
Abrahamson, NEW SPECIES
(Figs. 7-11)

Diagnosis.—Three northeastern United States species of *Neuroterus* are similar to this new species on the basis of galls: *N. dubius* Bassett (egg-shaped capsule galls on the edge of leaves on aments (Kinsey 1923)); *N. exiguus* Bassett (galls a fleshy enlargement of the staminate axis (Weld 1959), or anther galls but very succulent and shrivel up and disappear after adults emerge (Bassett 1900)); and *N. pallidus* Bassett (galls are in clusters, usually on the end of catkins). Adults of all three mentioned species have character states that differ from *N. chapmanii*. *Neuroterus dubius* has notauli and a coriaceous scutellum while the other three species lack notauli and have a smooth, shiny scutellum. *Neuroterus exiguus* has deep tentorial pits and the head in front view is nearly as high as broad, while in *N. chapmanii* and *N. pallidus* the head in front view is broader than high with shallow tentorial pits. In *N. chapmanii*, the head has a faint malar groove and the POL:OOL is as 3.5:2.0, while the



Figs. 1-11. 1-6, *Neuroterus archboldi*. 1, Female head, front view. 2, Antenna of female. 3, Antenna of male. 4, Fore wing of female. 5, Typical arrangement of galls on leaf (1×). 6, Saggital section of gall showing larval chamber (10×). 7-11, *N. chapmanii*. 7, Female head, front view. 8, Antenna of female. 9, Antenna of male. 10, Fore wing of female. 11, Shape of a single gall (30×).

head of *N. pallidus* lacks a malar groove and the POL:OOL is as 3.0:2.0.

Description.—Bisexual female: Dark brown to black. Head from above about twice as wide as long, broader than thorax, gena not broadened behind eye; interocular space coriaceous, broader than high; distance between antennal sockets same as distance between antennal socket and eye; frons coriaceous, broader than high, with densely and uniformly distributed short pale setae; clypeus rounded, its apex lighter, emarginate; malar space very short, with faint groove; mouthparts yellowish brown (Fig. 7). Antenna 12- or 13-segmented (some specimens with suture between 12th and 13th segments indistinct), pale yellow, with short pale dense setae; longer than head and thorax together; F1 as long as pedicel and scape together, two times longer than F2 (Fig. 8). Scutum rounded, slightly longer than broad, smooth and shiny, very finely coriaceous, without trace of notauli, anterior parallel and parapsidal lines. In specimens with shrunken and collapsed thorax, median line and anterior parallel lines appear as dark lines. Posterior margin of scutum slightly emarginate on both sides from transverse groove at base of scutellum; groove large, smooth, incurved. Scutellum smooth, shining, very finely coriaceous with uniformly distributed short pale setae; slightly elongated. Pronotum and mesepisternum finely coriaceous, slightly lighter than scutum. Median part of propodeum uniformly coriaceous, some specimens with distinct median carina, some without carina. Fore wing longer than body, uniformly and densely pubescent, with cilia on margins, without smoky spots; veins thick, brown except paler Rs+M which reaches M; areolet triangular, large; length 1.5 mm (Fig. 10). Legs, including coxae, pale, semitranslucent; basal part of coxae and femora dark brown; pretarsus dark brown or black; claws without tooth. Gaster black, smooth, in dry specimens shrunken and wrinkled, higher than long; ovipositor straight, tip not hooked; ventral

spine of hypopygium with short sparse pale setae, prominent, visible laterally. Length, 1.1 mm. Male: Color lighter than female. Eye considerably larger than in female, anterior tentorial pits deep; malar space shorter than in female; antenna 14-segmented, F1 longer than in female, very slightly curved and extended posteriorly (Fig. 9). In specimens with shrunken and collapsed thorax, median line and anterior parallel lines visible as dark lines. Fore wing longer than in female, 1.8 mm. Petiole long. Length, 1.2 mm.

Types.—Holotype ♀, allotype ♂, 17 ♀ and 7 ♂ paratypes. Archbold Biological Station, Lake Placid, Highlands Co., Florida, 6 March 1995, emerged 8 March 1995. Holotype, allotype, 4 ♀ and 2 ♂ paratypes and galls in the USNM; 4 ♀ and 2 ♂ paratypes and galls in AMNH; 9 ♀ and 3 ♂ paratypes and galls in G. Melika private collection.

Etymology.—Named from the host, *Quercus chapmanii*.

Distribution.—Florida (Archbold Biological Station, Lake Placid, Highlands Co.; Jonathan Dickinson State Park, Martin Co.).

Biology.—Only the bisexual generation is known. Galls are on catkins of *Quercus chapmanii*, are ovoid, thin walled, up to 1.5 mm long, and with a groove running from one side to the other across the upper surface thus resembling a closed purse (Fig. 11). The gall is covered with white pubescence, especially on the top, and is monothalamous. Galls are randomly scattered along the staminate axis and perpendicular to it. Sometimes two galls develop together. The galls are surrounded by anthers. As the gall and catkins mature, the color changes from green to pale brown. They remain on the catkins until emergence of the adult or longer, dropping along with the catkins. In Florida, on the Lake Wales Ridge, Chapman oak begins to flower the end of February to early March. We found the gall for the first time on 3 March 1995 when some of the galls had emergence holes, likely

made by the gall-inducing wasps; also, pupae and adult wasps were cut from the galls on this date. The galls are found easily throughout the period of Chapman oak flowering. No inquilines were reared from these galls, but some parasitoids belonging to the Tetrastichinae (Hymenoptera: Eulophidae) emerged. This is a very common species on *Q. chapmanii* on the Lake Wales Ridge. Our efforts to rear the alternate unisexual generation were unsuccessful in spite of using cages containing emerged wasps on the branches of Chapman oaks.

***Neuroterus christi* Melika and
Abrahamson, NEW SPECIES**
(Figs. 12-16)

Diagnosis.—The female appears most similar to *N. quercusirregularis* but differs by the parallel inner margins of the eyes, shallow tentorial pits, smaller clypeus, and ratio of the third antennal segment to the first two together (1.7:1.0). In *N. quercusirregularis*, the eyes slightly converge inward at the posterior part of the frons; the anterior tentorial pits are deep, and the ratio of the third antennal segment to the first two segments combined is 1.3:1.0. The galls are also quite similar in appearance to those of *N. quercusirregularis*, but those of *N. christi* are strictly associated with *Q. geminata* and *Q. virginiana* Mill., not nearly so succulent, and usually of a regular cylindrical shape and not so irregularly shaped as those of *N. quercusirregularis*.

Description.—Bisexual female: Brown to dark brown. Head from above about 3 times wider than long, broader than thorax; gena not broadened behind eye, inner margins of eyes parallel; interocular space finely punctate, blackish brown to black, broader than high; POL to OOL as 1.7:1.0; distance between antennal sockets smaller than between antennal socket and inner margin of eye; antennal apodemes distinctly depressed anteriorly; frons lighter than vertex and body, coriaceous, broader than high, with densely and uniformly distributed short pale setae, with

median elevation in form of broad carina that widens posteriorly to width of clypeus and reaches antennal sockets; clypeus lighter than body and vertex, rounded, very slightly emarginated posteriorly; tentorial pits shallow; malar space short, with distinct malar groove (Fig. 12). Antenna 13-segmented, lighter than body, F1 slightly longer than pedicel and scape together and 2 times longer than F2 (Fig. 13). Scutum rounded, slightly longer than broad, smooth and shining, very finely coriaceous, without trace of notauli, anterior parallel, median, and parapsidal lines; however, possibly indicated by darker lines; with scattered very short pale setae; posteriorly emarginate on both sides from transverse groove at base of scutellum. Scutellum slightly longer than broad, smooth, shiny, very finely coriaceous, with very few scattered short pale setae; transverse groove anteriorly very distinct, deep, smooth, slightly incurved. Pronotum and mesepisternum shining, finely coriaceous. Medial part of propodeum finely punctate, without carinae, shiny and smooth on both sides. Fore wing hyaline, with cilia on margins, with smoky spot along M distally from areolet and with a very small darker smoky spot on junction of M+Cu₁ to M. Fore wing 1.9-2.0 mm long, slightly longer than body, areolet present, closed; Rs+M lighter than other veins (Fig. 15). Coxae and trochanters pale yellow, semitranslucent, sometimes tips of coxae brown; femora and tibia brown, tarsi yellowish brown, pretarsi blackish brown; claws without tooth. Gaster dark brown to black, smooth, higher than long; tip of ovipositor hooked; ventral spine of hypopygium prominent, visible laterally, with pale scattered setae. Length, 1.7 mm. Male: Color lighter than female. Eye larger than in female; antenna 14-segmented; F1 longer than pedicel and scape together, slightly curved and extended posteriorly (Fig. 14). Fore wing 2.2 mm long; body 1.6 mm long.

Types.—Holotype ♀, Bok Tower Gar-

dens, Polk Co., Florida, on *Q. geminata*, 26 March 1995, emerged 26-27 March 1995. Allotype ♂, Lake Manatee State Recreation Area, Manatee Co., Florida, on *Q. geminata*, 9 April 1995, emerged 10 April 1995. 10 ♀ and 5 ♂ paratypes. Holotype, allotype, 3 ♀ and 2 ♂ paratypes and galls in the USNM; 3 ♀ and 1 ♂ paratypes and galls in AMNH; 4 ♀ and 2 ♂ paratypes and galls in G. Melika private collection.

Other material examined.—13 ♀ and 9 ♂, in addition to the two above-mentioned localities, from Buck Island Ranch, 13 km SW Brighton (Archbold Biological Station property), Highlands Co., Florida, on *Q. virginiana*, coll. 17 March 1995, emerged 26 March 1995.

Etymology.—Named in honor of Ms. Christy Raye Abrahamson, who provided continuous support during our seven months of research based at the Archbold Biological Station, and who first found this species.

Distribution.—Florida (Archbold Biological Station and 13 km SW Brighton, Buck Island Ranch, Highlands Co.; Lake Manatee Recreation Area, Manatee Co.; Bok Tower, Polk Co.; Eglin Air Force Base, Okaloosa and Walton cos.; Wakull Spring State Park, Wakulla Co.).

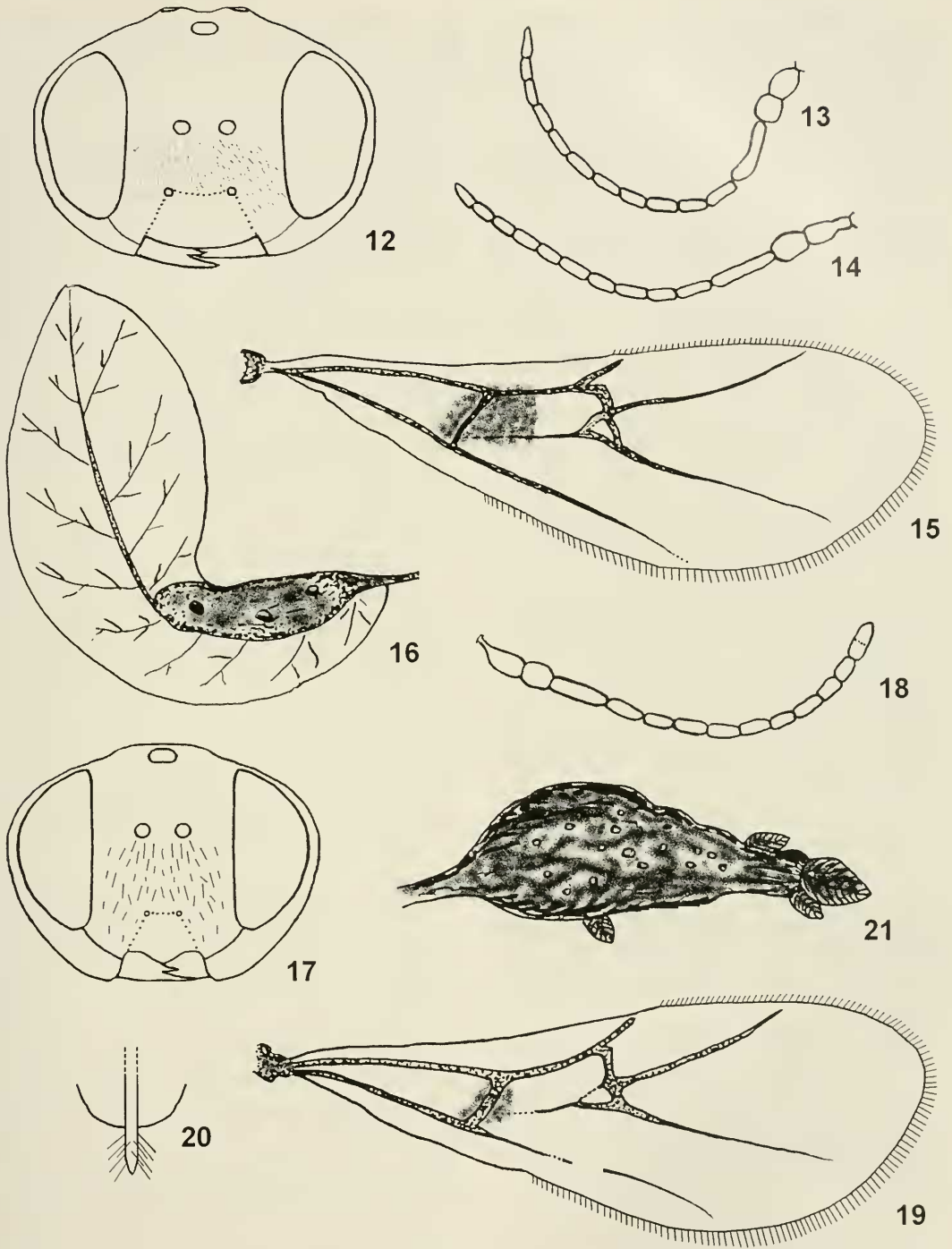
Biology.—Only the bisexual generation is known. The host oaks are *Quercus geminata* and *Q. virginiana*. The galls are leaf parenchyma thickenings, equally protruding on both sides of the leaf along one side of the main vein, green when young but turning brownish green when mature, polythalamous, generally with four to six larval cells per gall, about 12.0-15.0 mm long, 3.0-4.5 mm wide, and 3.0-4.5 mm high, and usually of a regular cylindrical form. The walls of the inner cells are whitish green and the surface of the gall is smooth, without hairs (Fig. 16). There are usually one or two galls per leaf. Adults usually emerge from the upper side. The first galls appear in mid-March, and the

adults emerge the last week of May and beginning of June.

Neuroterus weldi Melika and
Abrahamson, NEW SPECIES
(Figs. 17-21)

Diagnosis.—This species is related to *N. quercusbatatus* (Fitch), but the gena are broadened behind the eyes; a distinct carina on the vertex reaches between the antennal sockets; the area around the antennal sockets is depressed; the medial carina on the frons is distinct only in the lower half; the ratio between the first four antennal segments (1+2:3:4) is 1.16:1.03:0.63; and, in dried specimens, the height and length of the gaster is similar, but in some specimens the gaster is longer than high. In *N. quercusbatatus*, the genae are not broadened behind the eyes; the carina on the vertex is less distinct; the area around the antennal sockets is less depressed; the median carina on the frons is longer and reaches the antennal sockets; the ratio between the first four antennal segments (1+2:3:4) is 0.93:0.77:0.57; and, in dried specimens, the gaster is higher than long. The phenology and gall structure of both species also differ (see biology section of both species).

Description.—Unisexual female: Brown to red brown, with dark brown to black gaster. Head piceous, from above about 2 times wider than long, broader than thorax, gena broadened behind eye; interocular space coriaceous, broader than high; distance between antennal sockets smaller than between eye and antennal socket; distinct carina on vertex reaching antennal sockets; frons coriaceous, broader than high, with densely and uniformly distributed short pale setae; median carina on frons indistinct, never extending between antennal sockets (like that in *N. quercusbatatus*); malar space well developed with deep malar groove; frons and clypeus lighter than rest of head, piceous; mouthparts of same color as frons and clypeus; tip of mandible black (Fig. 17). Antenna 13-segmented, longer than head and thorax together, pedicel and



Figs. 12-21. 12-16, *Neuroterus christi*. 12, Female head, front view. 13, Antenna of female. 14, Antenna of male. 15, Fore wing of female. 16, Shape and usual location of gall (3.5 \times). 17-21, *N. weldi*. 17, Female head, front view. 18, Antenna of female. 19, Fore wing of female. 20, Ventral spine of hypopygium of female, ventral view. 21, Shape of gall (2.5 \times).

scape flattened; scape slightly longer than broad; first 3 segments piceous, rest dark brown to black; ratio between first 4 segments (1+2:3:4) as 1.16:1.03:0.63 (Fig. 18). Scutum rounded, slightly longer than broad; brown, smooth and shining, finely coriaceous, without trace of notauli, anterior parallel, median, and parapsidal lines; posterior margin slightly emarginate on both sides from transverse groove at base of scutellum; groove distinct, with shiny bottom. Scutellum piceous, much lighter than scutum, rounded, slightly longer than broad, smooth, shiny, finely coriaceous, with few short and uniformly distributed pale setae. Pronotum and mesepisternum finely coriaceous. Median part of propodeum uniformly finely coriaceous punctate; sides similar. Fore wing translucent, with uniform very short pubescence, with cilia on margins, some specimens with only trace of smoky spot at junction of M to Cu₁ and on 2r-m; veins thick, brown, areolet large, triangular, Rs+M reaches M (Fig. 19); length 1.9-2.1 mm. Legs uniformly red brown, with black pretarsi; claws simple, without tooth. Gaster black, smooth, slightly longer than high; ovipositor tip hooked; hypopygium with few short sparse setae (Fig. 20). Length, 1.6-1.8 mm.

Comments.—Weld (1959) wrote of a stem swelling found on *Q. chapmanii*, but he never reared the adults and consequently did not describe the species. The galls induced by *N. weldi* are probably those Weld described.

Types.—Holotype ♀ and 17 ♀ paratypes. Air Force Range, Avon Park, Highlands Co., Florida, 9 February 1995, emerged 16 February 1995. Holotype and 4 paratypes in the USNM; 4 paratypes in AMNH; 9 paratypes in the private collection of G. Melika.

Etymology.—Named after the American cynipidologist L. H. Weld who probably first found the galls of this species.

Distribution.—Central and coastal sandridges of south central Florida (Archbold Biological Station, Lake Placid, Highlands

Co.; Avon Park Air Force Range, Highlands Co.; Jonathan Dickinson State Park, Martin Co.).

Biology.—Only the unisexual generation is known. The gall is cylindrical, mostly a terminal stem swelling, covered with normal bark, on second year or older twigs and branches only of *Quercus chapmanii*. It is 25.0-40.0 mm long, 6.0-9.0 mm in diameter, and polythalamous (Fig. 21). Galls are not woody, rather they are easily cut like cheese. The leaf petioles are never involved in gall formation. Galls persist on stems for several years. Fully developed adults overwinter in galls and emerge from the second half of February into March of the following spring. The first galls observed are formed by the end of May.

Neuroterus quercusbatatus (Fitch)

Cynips Quercus-batatus Fitch 1859: 810.

Females and males (type examined).

Neuroterus batata Basset: Ashmead 1885a: 296, 303.

Neuroterus batatus form *bisexualis* Kinsey 1920: 334.

Neuroterus (Dolichostrophus) batatus var. *batatus* form *bisexualis* Kinsey 1923: 4.

Neuroterus quercusbatatus: Burks 1979: 1074.

Cynips noxiosus Bassett 1881: 108. Females, males, galls of both generations (types examined). **New synonymy.**

Neuroterus noxiosus form *vernalis* Kinsey 1920: 337. Bisexual generation.

Diagnosis.—This species closely resembles *N. weldi*; see diagnosis for that species.

Redescription.—Female: Brown to red brown. Head from above 2 times broader than long, broader than thorax, gena only very slightly broadened behind eye; interocular space coriaceous, broader than high; distance between antennal sockets nearly same as distance between eye and antennal socket; frons coriaceous, broader than high, with uniformly distributed short pale setae; median carina on frons reaches between antennal sockets; malar space well developed

with deep groove; frons, clypeus, and mouthparts of same color as rest of head, in some specimens lighter; tip of mandible dark brown to black. Antenna 13-segmented, brownish yellow, sometimes pale yellow, slightly longer than head and thorax together; 3 apical flagellomeres dark brown; pedicel and scape flattened; scape slightly longer than broad; ratio between first 4 segments (1+2:3:4) as 0.93:0.77:0.57. Scutum rounded, slightly longer than broad, brown black, smooth and shiny, finely coriaceous, without trace of notauli, anterior parallel, median, and parapsidal lines. Scutellum dark brown to black, rounded, only very slightly longer than broad, smooth, shiny, finely coriaceous, with densely and uniformly distributed pale setae; posterior margin slightly emarginate on both sides from transverse groove which is shiny. Pronotum, mesepisternum finely coriaceous. Medial part of propodeum uniformly coriaceous punctate; sides similar. Fore wing translucent, with uniform, very short pubescence, with cilia on margins; veins thick, brown, areolet large, triangular. Legs brown; coxae, centers of femora, and hind tibia somewhat darker; claws without tooth. Gaster larger than thorax, brown, sometimes brown black, usually same color as thorax and head, higher than long; ovipositor tip hooked, ventral spine of hypopygium with few short sparse white setae. Length, 1.2-2.2 mm. Females of both generations quite similar, impossible to distinguish them on basis of morphological characters. Male: Similar in color to female; thorax red brown laterally; legs and antenna uniformly yellow; gaster with petiole piceous or lighter in color; eyes only slightly enlarged; F1 not longer than that of female.

Distribution.—Ontario, Rhode Island, Connecticut west to Illinois, Colorado, south to Florida.

Biology.—Alternate bisexual and unisexual generations are known. Both generations induce stem-swelling galls on *Quercus alba* L. (Ashmead 1885a, Burks 1979). In Florida, the galls of the bisexual gener-

ation also develop on *Q. chapmanii* and *Q. margaretta*. The gall is a woody, elongate stem swelling. It is polythalamous, with an irregular shape and a surface that is covered by normal bark, twisted, but in large part cylindrical, tapering gradually to the stem at both ends and up to 20 mm long and 8 mm wide in the bisexual form and 60 mm long by 20 mm wide in the unisexual form. Sometimes several galls can more or less fuse, drying brown in bisexual forms, with a whitish or purplish bloom in unisexual forms. Internally hard and woody, the tissue is little modified except by the larval cells which are densely packed, each with a distinct but wholly inseparable lining. The unisexual form develops on young stems, involving petioles and leaf midveins; the bisexual form is on older stems involving the bases of the petioles. The unisexual form begins to develop in mid-summer, forming woody stem galls. The adults overwinter in the galls and emerge in spring after the oaks are actively growing. The galls of the bisexual generation are less woody, usually on younger twigs, and develop in late spring to early summer. The adults emerge in June and July.

Neuroterus quercusirregularis
(Osten Sacken)

Cynips q. irregularis Osten Sacken 1861: 65. Species described from one damaged male (sex not certain) and one gall. Type lost.

Neuroterus irregularis: Ashmead 1885a: 296, 304.

Neuroterus quercusirregularis: Burks 1979: 1074.

Cynips quercus-majalis Bassett 1864: 683. Females, males, galls (types examined).

New synonymy.

Neuroterus majalis: Mayr 1881: 37.

Neuroterus (Dolichostrophus) irregularis var. *majalis*: Kinsey 1923: 100.

Diagnosis.—This species is very closely related to *N. christi*; see diagnosis of that species. *Neuroterus quercusirregularis* is

associated with the *Quercus chapmanii*-*Q. margaretta*-*Q. stellata* Wangenh. group, while the closely related *N. christi* is found only on *Q. virginiana* and *Q. geminata*.

Redescription.—Female: Head largely dark brown to black, finely coriaceous; gena not broadened behind eye; frons with uniformly distributed short pale setae; eyes enlarged, malar space very short with malar groove; clypeus rounded, emarginated posteriorly, slightly lighter than frons. Antenna brown, yellow to whitish basally, 13-segmented, F1 2 times or more longer than F2. Thorax black, only slightly longer than high or wide. Scutum and scutellum smooth, shiny, very finely coriaceous, without setae. Pronotum and mesepisternum finely coriaceous. Fore wing densely pubescent, much longer than the body, with cilia on margins; areolet usually moderate, but variable in size; with very light smoky spot a midpoint of M. Legs entirely pale yellow or whitish, semitranslucent; pretarsi black; claws without tooth. Gaster black or very dark brown, shining and smooth, higher than long. Length, 1.5-2.0 mm. Male: Head dark brown to black, lower part of frons lighter than in female; eye considerably enlarged, malar space very short. Antenna generally lighter than in female, pale yellow or yellow white, with F1 much lengthened, distinctly curved, 2 times longer than both pedicel and scape together and nearly 4 times longer than F2. Thorax considerably longer than in female, light brown, laterally yellow to whitish. Fore wing much longer than body. Legs whitish, semitranslucent. Male slightly larger than female.

Comments.—We found no evidence to differentiate *N. quercusirregularis* from *N. quercusmajalis*. Beutenmueller (1910) wrote about *N. quercusmajalis*: "Allied to *N. q. irregularis* in color . . . , and the only perceptible difference that I can find between the two species is in size." Bassett (1864) mentioned that it is quite similar to Osten Sacken's *C. q. irregularis*, but related to other species of oak. Kinsey (1923) treated *N. quercusmajalis* as a variety of *N. ir-*

regularis, and described coloration as the only difference. Unfortunately, the type male of *N. quercusirregularis*, originally designated by Osten Sacken, is lost. Except for slight difference in coloration, we found no morphological differences between *N. quercusmajalis* and *N. quercusirregularis* in either sex. Consequently, we regard these species as synonymous.

Distribution.—Ontario, New York, Massachusetts, Connecticut, New Jersey, Maryland, Virginia, west to Illinois, Missouri, Oklahoma, Texas, and southward (Beutenmueller 1910). We found this species in North Carolina (vicinities of Arapahoe, Pamlico Co., on *Q. stellata*), and in Florida (common, locally abundant, occurs everywhere the host plants grow: Jonathan Dickinson State Park, Martin Co.; Archbold Biological Station, Highlands Co.; Winegarner's property in the vicinity of De Funiak Springs, Walton Co., and throughout the panhandle and south central Florida).

Biology.—Only the bisexual generation is known to induce integral leaf galls on *Quercus alba* and *Q. montana* Willd. (Ashmead 1885a, Beutenmueller 1910, Kinsey 1923, Weld 1959), and *Q. chapmanii* and *Q. stellata* (Burks 1979). We frequently found this species on *Q. margaretta* as well. According to Kinsey (1923), *N. quercusirregularis* var. *albipleurae* Kinsey induces galls on *Q. breviloba* (in Texas only). The gall is a leaf parenchyma thickening, with the larval cells mostly deeply embedded, and is polythalamous. It is usually elongate, oval, as thick as wide, up to 5.0 mm wide by 15.0 mm long, several galls often fusing, green, very succulent, shriveling considerably upon drying, and the larval cell has a distinct but inseparable layer. The galls are smooth and large when on *Q. alba* and the pubescence is denser and the galls are smaller when on *Q. stellata*, *Q. margaretta*, or *Q. chapmanii*. Galls usually appear on very young, unfolding leaves, very quickly mature, and develop from April until early June, earlier farther south. Adults emerge from May through July.

Neuroterus quercusminutissimus
(Ashmead)

Cynips q. minutissima Ashmead 1885a: 7.
Females only.

Neuroterus minutissimus: Ashmead 1885b:
296.

Neuroterus (Diplobius) verrucarum var.
minutissimus: Kinsey 1923: 72.

Diagnosis.—The sculpture of the pronotum in *N. quercusverrucarum* is duller than in *N. quercusminutissimus*. The gaster in *N. quercusminutissimus* is sharply triangular, considerably higher than long, and smaller than the head and thorax together, while in *N. quercusverrucarum*, the gaster is more prolonged and nearly the same length as the head and thorax together. The gall resembles that of *N. quercusverrucarum*; however, the cynipid species composition on *Q. virginiana*-*Q. geminata*-*Q. minima* is very specific. No other host plants have been recorded for the 14 species of oak cynipids that occur on the closely related group of oak species. Thus, knowledge of the host species is very helpful in the identification of species. *Neuroterus quercusverrucarum* and *N. quercusminutissimus* are both very common in Florida; however, the former species is associated with *Q. chapmanii*, *Q. stellata*, and *Q. margaretta*, while the latter species is hosted by *Q. virginiana*, *Q. geminata*, and *Q. minima*.

Redescription.—Female: Entire body black, only clypeus and mandible light brown. Head from above 2 times wider than long, broader than thorax, gena only very slightly broadened behind eye; interocular space, vertex, and frons of same coriaceous sculpturing; frons with uniformly densely distributed short pale setae; malar space moderately large, with faint groove. Antenna 13-segmented, yellowish brown, F1 longest flagellomere, but only slightly longer than F2. Scutum and scutellum both rounded, shiny, very finely coriaceous, with very few short pale setae on scutum and with uniformly distributed dense short white setae on scutellum; without trace of notauli,

anterior parallel, median, and parapsidal lines; transverse groove at base of scutellum large, with smooth, shiny bottom. Pronotum and mesepisternum same color as scutum, very finely coriaceous. Fore wing translucent, with cilia on margins, longer than body; veins thick, yellowish, only Rs+M much paler; areolet triangular, distinct. Legs yellowish brown; coxae, femora, and tibiae infuscated along upper surface; claws without tooth. Gaster black, shiny, higher than long, sharply triangular in outline; ovipositor straight, tip not hooked; ventral spine of hypopygium prominent, visible laterally. Length, 0.5-1.3 mm.

Distribution.—Florida. Common everywhere *Quercus geminata*, *Q. minima*, and/or *Q. virginiana* grows.

Biology.—Only the unisexual generation is known. This species induces small, 1.25-2.50 mm, detachable galls, covered with coarse, light brown mossy pubescence, on the underside of leaves in numbers in the fall on *Quercus geminata*, *Q. virginiana*, and *Q. minima*. In Florida, adults emerge early in the spring, but the galls do not develop until mid- to late summer. The fully grown adults overwinter in the galls.

Neuroterus quercusverrucarum
(Osten Sacken)

Cynips quercus verrucarum Osten Sacken
1861: 62. Females and galls (types examined).

Cynips verrucarum: Osten Sacken 1865:
354.

Neuroterus verrucarum: Ashmead 1885a:
296, 304.

Neuroterus quercusverrucarum: Burks
1979: 1075.

Neuroterus exiguissimus Bassett 1900: 332.
Females and galls (types examined). **New synonymy.**

Cynips flocossa Bassett 1881: 111. Females and galls (types examined). **New synonymy.**

Neuroterus verrucarum var. *pernotus* Kinsey 1923: 74.

Neuroterus flocossus: Burks 1979: 1073.

Diagnosis.—See *Neuroterus quercusminutissimus*.

Description.—Female: See description and diagnosis for *N. quercusminutissimus*. Length, 0.7–1.5 mm.

Comments.—We found no morphological differences in adults, galls, and phenology of *N. quercusverrucarum*, *N. exiguissimus*, and *N. floccosus*; consequently we treat them as synonyms. Kinsey (1923) described ten varieties of this species, one of which, *N. verrucarum* var. *restrictus* Kinsey, was from Florida on *Quercus chapmanii*. He indicated that this variety was collected also on *Q. margaretta* and *Q. geminata*. In our opinion, the latter reference concerns *N. quercusminutissimus*.

Distribution.—Ontario, New York, New Jersey, Connecticut, west to Illinois, Oklahoma, Texas, south to Florida.

Biology.—Only the unisexual generation is known. This species induces detachable leaf galls which are small, smooth, seed-like larval cells, hard, thin-walled, and covered with a dense flattened yellowish brown mass of wool that dries brown. The gall is monothalamous, attached to the underside of the leaf by a small point to the leaf vein, separable, but the leaf is depressed at the point of attachment. The average diameter of a gall is 2.0 mm by 1.0 mm high. The galls are usually numerous, covering the whole underside of the leaf and are found on *Quercus alba*, *Q. bicolor* Willd., *Q. chapmanii*, *Q. margaretta*, and *Q. stellata*. Viereck (1916) also recorded *Q. macrocarpa* Michx. as a host, but this must be confirmed. Galls begin to develop in September (Weld 1959). According to Kinsey (1923), the galls appear after mid-summer in August and the larvae do not mature until late in the fall. Adults emerge the next spring in February to March.

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